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AIR FILTRATING SELF-PROPELLED UPRIGHT VACUUM CLEANER

FIELD OF THE INVENTION

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This application claims the benefit of U.S. Provisional Application No. 60/035,357, filed January 10, 1997.

The present invention relates to a self-propelled upright vacuum cleaner comprising a unique HEPA-rated air filtration system. The present invention also relates to a self-propelled upright vacuum cleaner having a thermal cut-off circuit, a novel air routing configuration within the unit, and numerous other improvements and features.

There is an increasing emphasis upon the cleanliness of air discharged from vacuum cleaners. Prior artisans have attempted to provide secondary filters for vacuum cleaner exhaust air streams. Although satisfactory in most respects, most known secondary filtering configurations are difficult to design and incorporate within the vacuum cleaner, thereby increasing the complexity, manufacturing time, and cost of the unit. Furthermore, for assemblies employing replaceable filter elements, there is often considerable difficulty in replacing the element, particularly if it is located within the vacuum cleaner. Accordingly, there is a need for a vacuum cleaner comprising a secondary filtering assembly that overcomes the problems of the prior art. It would be particularly desirable to provide a vacuum cleaner with an easily replaceable filter element in combination with a sealed air path so that all air exiting the vacuum cleaner unit traveled through the filter prior to exiting the vacuum cleaner.

Air leaks from a vacuum cleaner unit, such as leakage of the exhaust stream around the motor housing into the environment, not only introduce particulates and contaminants into the outside environment and thus bypass

1 objectives and provides in a first aspect, a vacuum cleaner
2 comprising a housing and a base unit pivotally attached to
3 each other, a motor and motor housing disposed within the
4 base unit, a drive assembly also disposed within the base
5 unit and selectively coupled to the motor, a nested wand
6 releasably retained along the exterior of the housing, a
7 lower air conduit extending between the base unit and a
8 lower end of the wand, and an upper air conduit extending
9 between an upper end of the wand and a suction chamber
10 defined within the housing.

11 In another aspect, the present invention provides a
12 vacuum cleaner comprising a lower base unit, an upper
13 pivotable enclosure for housing a filter bag, a motor
14 disposed within the lower base unit, a power cord and
15 associated electrical conductors defining an electrical
16 power circuit to the motor, and a thermal cutoff assembly
17 including a temperature sensor disposed proximate to the
18 motor for measuring the temperature of the motor, the
19 thermal cutoff assembly including a switching element in
20 the electrical power circuit that opens upon the
21 temperature sensor sensing a temperature greater than a
22 predetermined temperature setpoint.

23 In yet another embodiment, the present invention
24 provides a vacuum cleaner comprising a lower base unit, an
25 upper enclosure for retaining a filter bag, the upper
26 enclosure defining a suction chamber, and exhaust chamber,
27 and an exhaust opening providing access from the exterior
28 of the upper enclosure to the exhaust chamber, a motor and
29 fan assembly disposed within the upper enclosure and in
30 airflow communication between the suction chamber and the
31 exhaust chamber, and a detachable filter assembly that
32 releasably engages the upper enclosure at or near the
33 exhaust opening.

34 In yet another aspect, the present invention provides
35 a vacuum cleaner comprising a lower base enclosure, an
36 upper enclosure having internal walls dividing the upper
37 enclosure into a suction chamber, an exhaust chamber, and a
38 motor chamber, a motor and fan assembly disposed in a

1 shroud which resides in the motor chamber, an air intake
2 duct extending between the suction chamber and the shroud.
3 The air intake duct engages either or both the suction
4 chamber and the shroud along an unsealed interface.

5 According to a further aspect of this invention a
6 motor and transmission module selectively powers a base
7 drive wheel and at least the motor of the module is encased
8 in a shroud. The shroud is connected by an exhaust
9 passageway to the air flow path leading ultimately to the
10 final filter.

11 BRIEF DESCRIPTION OF THE DRAWINGS

12 FIG. 1 is a perspective view of a preferred embodiment
13 vacuum cleaner in accordance with the present invention;

14 FIG. 1A is an exploded view of the preferred
15 embodiment vacuum cleaner illustrated in FIG. 1;

16 FIG. 1B is a side elevational view of the preferred
17 embodiment vacuum cleaner illustrated in FIG. 1;

18 FIG. 2 is a partial exploded view of the preferred
19 embodiment vacuum cleaner housing, illustrating in greater
20 detail the direction of airflow within the housing;

21 FIG. 2A is a detailed view of the assembled housing
22 shown in FIG. 2 having a bag cover removed;

23 FIG. 2B is another view of the housing shown in FIG. 2
24 with the bag cover removed;

25 FIG. 3 is a perspective view of the rear of the
26 preferred embodiment vacuum cleaner;

27 FIG. 4 is a detailed view illustrating the affixment
28 of a preferred embodiment detachable filter to the rear
29 housing of the preferred embodiment vacuum cleaner;

30 FIG. 4A illustrates the filter shown in FIG. 4
31 attached to the rear housing and the direction of airflow
32 from the preferred embodiment vacuum cleaner;

33 FIG. 5 is a detail of the preferred embodiment filter
34 used in the preferred embodiment vacuum cleaner;

1 FIG. 6 is another view of the preferred embodiment
2 filter;

3 FIG. 7 is a schematic cross-sectional view of the
4 preferred embodiment filter illustrating its orientation to
5 the floor when the preferred embodiment vacuum cleaner is
6 set to a fully reclined position;

7 FIG. 8 is an exploded view of a suction motor and a
8 motor shroud used in the preferred embodiment vacuum
9 cleaner;

10 FIG. 9 is a detailed view of the motor shroud shown in
11 FIG. 8;

12 FIG. 10. is another detailed view of the motor shroud
13 shown in FIG. 8;

14 FIG. 11 is a detailed view of the engagement between a
15 hose adapter and the housing of the preferred embodiment
16 vacuum cleaner;

17 FIG. 11A is an elevational view of the adapter and
18 housing assembly depicted in FIG. 11;

19 FIG. 12 is a fragmentary view of the vacuum cleaner
20 base illustrating the drive module and air flow
21 therethrough; and

22 FIG. 13 is a partially cross-sectional view of the
23 handle assembly.

24 DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 Referring to FIGS. 1, 1A, 1B and 3, a preferred
26 embodiment vacuum cleaner 10 in accordance with the present
27 invention is illustrated. The vacuum cleaner 10 comprises
28 a rear housing 20, an upper front cover 30, a bag cover 80,
29 and a lower motor cover 50 that generally form the body of
30 the vacuum cleaner 10. The lower portion of the preferred
31 embodiment vacuum cleaner 10 comprises an upper base 40
32 having a front guard 120 and a plurality of wheels
33 including rear wheels 110. The upper portion of the
34 preferred embodiment vacuum cleaner 10 further comprises a

1 handle 90, a grip 100, and a side mounted tool caddie
2 insert 34. Disposed along the rear of the vacuum cleaner
3 10 is a final filter 60.

4 Referring specifically to FIG. 1A, other components of
5 the preferred embodiment vacuum 10 are as follows. The
6 handle 90 is disposed between the front cover 30 and the
7 upper portion of the rear housing 20. The handle 90
8 preferably has an arcuate bend proximate to its upper
9 distal end 91. The bend is such that the distal end 91 is
10 directed toward the rear of the vacuum cleaner 10. The
11 grip 100 is affixed to a handle cover 102 and this assembly
12 is slidably mounted on the upper distal end 91 of the
13 handle 90. Various switches and controls may also be
14 provided proximate to the distal end 91 of the handle 90
15 such as, but not limited to, a neutral lock mechanism 130
16 and related selector springs 132 and a selector spacer 134.
17 In addition, one or more switches may be located at the
18 distal end 91 of the handle 90 for controlling the
19 operation of the vacuum cleaner 10. Other controls such as
20 an on/off switch 140 and various potentiometer type
21 controls such as a slide control 142 are preferably
22 disposed and affixed to the front cover 30.

23 The upper base 40 and a lower base 180 engage each
24 other and generally form a lower enclosure that houses the
25 drive motor and brush assembly as follows. A drive motor
26 230 is disposed and retained within the enclosure formed by
27 the upper base 40 and the lower base 180. The drive motor
28 230 is operatively coupled to a transmission 240 that also
29 resides within the enclosure formed by the upper and lower
30 bases 40 and 180. Rotatably secured to, or retained
31 within, the lower base 180 are a plurality of wheels. A
32 pair of rear wheels 110 are rotatably affixed to the lower
33 base 180 by respective axles 111. Disposed proximate the
34 front of the lower base 180 is a wheel carriage 112 that
35 rotatably supports a front axle 116 having a pair of front
36 wheels 114 secured at its ends. Also disposed within the
37 enclosure formed by the upper base 40 and the lower base

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1 180 is a rotatable brush or disturbulator 170. The
2 disturbulator 170 is rotated by a disturbulator belt 172.
3 A belt cover 174 is utilized to cover the belt 172.

4 Referring further to FIG. 1A, preferably disposed
5 proximate to the lower portion of the rear housing 20 are a
6 suction motor 210 and a motor shroud 220. The suction
7 motor 210 draws air through the enclosure formed by the
8 upper and lower bases 40 and 180, i.e. in the vicinity of
9 the disturbulator 170, through a lower hose 72, a nested
10 wand 78, an upper hose 70, a bag filter 270 disposed within
11 a bag chamber described below, a second filter 260, an air
12 intake duct 250, through the motor shroud 220 and
13 eventually into the final filter 60 as described in greater
14 detail below. A single screw is utilized for engaging the
15 lower hose 72 connector to the lower base 180. A hose
16 union 74 and other conventional coupling assemblies may be
17 used to complete the airway. A unique releasably locking
18 hose adapter 71, described in greater detail below, is
19 preferably utilized to couple the upper hose 70 to the bag
20 chamber within the rear housing 20.

21 An electrical power cord 200 and one or more cord
22 release members 202 are provided along the rear of the
23 vacuum cleaner 10. The power cord 200 provides electrical
24 power to the suction motor 210 and the drive motor 230.
25 The preferred embodiment vacuum cleaner 10 also comprises a
26 headlight 150 and a lens 152 disposed in or upon the motor
27 cover 50. A height adjustment assembly and knob 160 is
28 provided for the lower base unit.

29 The preferred embodiment vacuum cleaner also comprises
30 a variety of cleaning tools or attachments. A side mounted
31 tool caddie insert 34 is preferably utilized to releasably
32 retain these tools such as for instance a crevice tool 190,
33 an upholstery nozzle 192, and a brush 194. An extension
34 wand 76 is also provided. An attachment tool is utilized
35 by detaching the hose 70 from the nested wand 78 at their
36 coupling along the rear of the vacuum cleaner 10, as best
37 depicted in FIG. 3. Upon release of the hose 70 from the

1 nested wand 78, one of the previously noted tools 190, 192,
2 or 194, or the extension wand 76 can be attached to the
3 free end of the hose 70.

4 Referring to FIG. 1B, another aspect of the preferred
5 embodiment vacuum cleaner 10 is the orientation of the
6 upper housing and handle 90 to the base when the vacuum
7 cleaner 10 is in its stationary upright position. This
8 position is reached when the vacuum cleaner is placed in
9 its accessory vacuuming mode. As evident in FIG. 1B, the
10 upper housing is preferably oriented forward at some angle
11 X from vertical. This orientation results in a more stable
12 assembly than if the upper housing were oriented along a
13 generally vertical axis. This becomes increasingly
14 important as the bag filter 270 (shown in FIG. 1A) fills up
15 with dirt and debris, thereby increasing in weight. It is
16 most preferred that the angle X be about $8-1/2^\circ$. The
17 present invention vacuum cleaners include other
18 configurations in which the upper housing and handle are
19 angled forward.

20 Referring further to FIG. 1A, a conventional handle
21 release 92 and a release spring 94 control the angular
22 orientation of the upper portion of the vacuum cleaner
23 housing and handle. The handle 90 and related attachments
24 such as switches and grips, may be entirely detachable from
25 the vacuum cleaner 10, or designed to pivot so that the
26 assembly may be folded downward toward the floor to a
27 horizontal, or substantially horizontal, position. It is
28 also contemplated that the handle could be mounted within
29 the upper portion of the vacuum cleaner body in such a way
30 that the handle becomes the movable portion or actuator
31 utilized to control the operation of the vacuum cleaner.
32 This would eliminate providing selector controls at the end
33 of the handle 90 such as the selector 130. In this
34 contemplated embodiment, the linkage connection to the
35 control cable, i.e. a sheathed transmission shifting cable
36 described below, would occur within the top portion of the
37 vacuum cleaner body or housing. In many or all of these

1 embodiments, it is further contemplated that the handle 90
2 could be designed so that it could be readily removed from
3 the main housing of the vacuum cleaner. This would
4 significantly reduce the size of the shipping carton and
5 reduce shipping costs. Other advantages would likely
6 include quick customer assembly and reduction in the number
7 of parts and parts costs. A reduction in the size of
8 shipping carton and parts would further allow the packaged
9 product to be more easily displayed in the sometimes
10 restricted shelf area found in many retail stores.

11 It is also preferred to utilize a tilt switch,
12 preferably disposed within the handle 90, that prevents
13 operation of the drive motor 230 depending upon the
14 position of the handle. Preferably, the switch opens or
15 closes an electrical control circuit depending upon the
16 angular orientation of the handle. A switch comprising a
17 ball bearing and raceway is disposed within the handle 90
18 and oriented such that when the handle is in an upright
19 position, the ball bearing rolls or otherwise moves to a
20 location along the raceway that results in an open
21 electrical circuit between the switch terminals. The
22 switch is also oriented so that when the handle is at any
23 other position than its upright position, i.e. and so
24 typically at some angle of inclination, the ball bearing
25 rolls or moves to a location along the raceway that results
26 in completion of the electrical pathway between the switch
27 terminals. The tilt switch is preferably utilized in a
28 control circuit governing operation of the drive motor 230
29 so that when the handle is in its upright position, the
30 drive motor 230 will not operate. It is also contemplated
31 that other types of switches utilizing other types of
32 movable elements could be used. Furthermore, other types
33 of interlocking switches could be used to prevent operation
34 of the drive motor 230 when the handle 90 is in its upright
35 position. It is envisioned that electrical contacts could
36 be provided between the tiltable body portion of the vacuum
37 cleaner and the base portion. The electrically conductive

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1 contacts would contact one another only when the handle was
2 tilted from its upright position. The contacts would be
3 incorporated into an electrical control circuit governing
4 operation of the drive motor 230. Moreover, the location
5 and placement of the switch could be elsewhere besides the
6 handle, such as for instance, within the housing or base
7 units of the vacuum cleaner.

8 The various housing, cover, and base components
9 described herein can be formed from a wide array of
10 materials. A preferred material is molded polyurethane.

11 The preferred embodiment vacuum cleaner 10 utilizes a
12 unique and novel filtered airflow system as follows.
13 Referring to FIG. 2, upon operation of the suction motor
14 210 generally disposed within the motor shroud 220, air is
15 drawn through the hose 70 and through the hose adapter 71
16 into the bag filter 270. After passing through the walls
17 of the bag filter 270, shown as arrow A in FIG. 2, air
18 enters a secondary filter 260 located at the inlet of the
19 air intake duct 250. Air passes through the air intake
20 duct 250 shown as arrow B until it exits the duct 250 at
21 the outlet shown as arrow C. The air then enters the inlet
22 of the motor shroud 220, shown as arrow D, and then is
23 directed through the outlet of the motor shroud 220 shown
24 as arrow E. The air is then directed to the final filter
25 60 as shown by arrow F. After passing through the final
26 filter 60; the air then exits the vacuum cleaner 10 through
27 laterally oriented airflow openings along the side of the
28 final filter 60 and described in greater detail below. The
29 air exits as shown as arrows G.

30 A bag chamber, i.e. an interior region that houses the
31 bag filter 270, is formed between the rear housing 20 and
32 the bag cover 80. During operation of the vacuum cleaner
33 10, the bag chamber is usually at a negative pressure, i.e.
34 a pressure less than atmospheric pressure.

35 The preferred embodiment motor shroud 220 generally
36 encloses the suction motor 210 and diverts all air through
37 the final filter 60. This configuration greatly simplifies

1 gasket design and sealing issues otherwise encountered if a
2 multi-component housing or shroud assembly was used.
3 Although a one-piece sealed shroud enclosing the suction
4 motor is preferred, the present invention includes
5 additional embodiments including the use of a by-pass duct
6 located either upstream, downstream, or on both ends of the
7 suction motor. Other sealed enclosures are contemplated
8 wherein the sealing is accomplished by conventional
9 gaskets, adhesives or component welding.

10 In a most preferred embodiment, air leaks are
11 significantly reduced by recirculating airflow within the
12 vacuum cleaner housing. Specifically, provisions are made
13 to prevent exhaust air leaks from escaping to the
14 environment before passing the air through the final filter
15 60. This is accomplished by maintaining a negative
16 pressure inside the vacuum cleaner housing, and
17 particularly within the enclosure formed between the rear
18 housing 20 and the bag cover 80. This region of negative
19 pressure may also extend in the vicinity behind the front
20 cover 30. Referring to FIGS. 2A and 2B, it is most
21 preferred to use an ungasketed joint between the air duct
22 250 and a mounting shelf 252 provided in the rear housing
23 20. The mounting shelf 252 defines an opening sized to
24 accept and preferably support an end of the air duct 250.
25 The interface between the opening and the outer periphery
26 of the air duct 250 is shown in FIGS. 2A and 2B as
27 interface 251. This interface is most preferably not
28 sealed. As a result, exhaust leaks occurring in and around
29 the upper portion of the air duct 250 are drawn into the
30 bag chamber. Similarly, by providing an ungasketed joint
31 between the lower region of the air intake duct 250 and the
32 inlet of the motor shroud 220, shown in FIG. 2B as joint
33 224, potential exhaust leaks in and around a gasketed
34 joint between the lower portion of the air duct 250 and the
35 suction motor 210 are drawn back into the motor shroud 220.
36 As can be seen, potential exhaust leaks from the positive
37 pressure side of the air handling system are recaptured

1 into the airstream instead of being exhausted to the
2 environment before passing the airstream through the final
3 filter 60. This is achieved by maintaining a negative
4 pressure inside the body or housing of the vacuum cleaner
5 10. The negative pressure inside the body or housing is
6 due to inherent and/or predetermined leaks between the
7 various airflow handling components which allow air to
8 enter the air intake duct 250 and the bag chamber.

9 In another preferred embodiment, a flexible conduit
10 shown in FIG. 2A as conduit 253 is provided between the
11 motor bearings and the suction side or negative pressure
12 side of the system. The conduit and resulting air flow
13 through the conduit captures particles and contaminants
14 otherwise leaking through the bearing or around the bearing
15 and into the atmosphere. In the absence of such conduit,
16 particles and contaminates leak from inside the enclosure
17 or motor shroud to the outside environment. Another
18 advantage of providing the flexible conduit 253 is that the
19 resulting airflow therethrough draws air through and around
20 the bearing thereby cooling the bearing and neighboring
21 components. Preferably and with reference to FIGS 2A and
22 8, the conduit 253 extends from a collar 590 disposed
23 proximate a motor bearing. The conduit 253 extends to a
24 location of lesser pressure, such as within the air duct
25 250. Other installation sites for the end of the conduit
26 253 may be utilized instead of the air duct 250. For
27 instance instead of terminating the end of the conduit 253
28 at the air duct 250, that end could be installed on the
29 shelf 252 so that the conduit 253 is in communication with
30 the region of the enclosure behind the filter wall 300.

31 The preferred embodiment vacuum cleaner 10 utilizes a
32 HEPA-rated final filter 60 best shown in FIGS. 4, 4A, 5, 6,
33 and 7. The HEPA filter captures at least 99.97% of
34 particles having a diameter of about 0.3 microns. The rear
35 housing 20 is particularly adapted for accommodating the
36 final filter 60. The rear housing 20 preferably comprises
37 a rear wall 390 disposed between transversely extending

1 the final filter 60 is attached to the vacuum cleaner 10.
 2 A retaining member 480 is preferably utilized to assist in
 3 releasably retaining the final filter 60 to the vacuum
 4 cleaner 10. A filter element 490 such as a paper filter
 5 element, is disposed within the enclosure formed by the
 6 outer cover plate 400 and the walls 410, 420, 430, and 440.

7 Referring to FIG. 7, during operation of the vacuum
 8 cleaner 10, air exiting the rear housing 20 flows through
 9 the filter element 490 and out of the final filter 60, i.e.
 10 through the airflow openings 460, which direct the air
 11 laterally outward. The airflow openings 460 are defined
 12 along the sidewalls 410 and 420. This is desirable,
 13 particularly when the vacuum cleaner 10 is in a fully
 14 reclined position such that its upper housing and handle
 15 are angled downward and near the floor 2. The laterally
 16 oriented openings 460 direct the exiting air stream away
 17 from the floor 2. The extent of reclining may be such that
 18 the handle is approximately horizontal. This orientation
 19 is useful so that the vacuum cleaner 10 has a low profile
 20 to thereby enable the vacuum cleaner to be used under
 21 furniture items and beds.

22 The separate and detachable final filter 60 offers
 23 additional advantages. By using an external one-piece
 24 final filter assembly, there is no need for a separate
 25 housing or cover to house and protect the filter element.
 26 Furthermore, by utilizing a curved configuration for the
 27 outer cover plate 400 of the final filter 60, exiting air
 28 is directed slightly upwards from the floor 2 when the
 29 vacuum cleaner is in a fully reclined position. This
 30 further minimizes debris on the carpet from being blown
 31 with the air. This is illustrated in FIG. 7. The rear
 32 cover plate 400 further acts as a shield to protect the
 33 paper filter element 490 and further deaden noise. In yet
 34 another embodiment, some of the various laterally disposed
 35 airflow openings 460 located along both sides of the final
 36 filter 60 can be eliminated and defined on only one side of
 37 the filter housing.

Referring to FIGS. 8, 9, and 10, the motor shroud 220 and suction motor 210 are illustrated in greater detail. The motor shroud 220 generally encloses the suction motor 210. The motor shroud 220 is preferably cylindrical, comprising an arcuate wall 540 and an endwall 544. The motor shroud 220 comprises a tangentially and outwardly extending air duct 530 defining a shroud opening 510 at its distal end 531. The air duct 530 is in airflow communication with the final filter 60 disposed behind the filter wall 300 as shown in FIG. 2A. The air duct 530 may be attached to the mounting shelf 252. Preferably provided proximate to the distal end 531 of the air duct 530 is a seal seat 532. The seal seat 532 supports a pliable and flexible seal 520 that reduces air leaks between the mounting shelf 252 and the air duct 530 of the motor shroud 220. One or more fasteners 570 and bosses 560 are used to affix and secure the assembly. A sealing and coupling ring 580 is preferably used between the suction motor 210 and the shroud 220. The assembly of the motor 210, the ring 580, and the shroud 220 is preferably disposed within the lower portion of the rear housing 20, and as best shown in FIG. 2A, against the second sidewall 320 of the rear housing 20. Most preferably, the assembly is concentrically aligned with the pivot hub 350 defined in that sidewall. An alignment and support collar 590 is preferably utilized, as shown in FIG. 8 to facilitate support and engagement between the shroud 220 and the pivot hub 350 in the second sidewall 320.

29 The motor shroud 220 utilizes an interior isolation
30 wall 500 as shown in FIG. 10. The isolation wall 500
31 generally blocks access to electrical components of the
32 suction motor 210 and serves as a sound insulating barrier
33 to decrease motor noise. Referring also to FIG. 9, the
34 motor shroud 220 also provides one or more terminal
35 apertures 550 that provide access to one or more electrical
36 terminals 212 of the suction motor 210. The preferred
37 embodiment for forming a seal between the motor terminals

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1 212 and the housing of the shroud 220 is by utilizing die
2 cut or molded rubber or plastic members that create a seal
3 within the motor terminal area. This prevents the motor
4 exhaust air escaping through the shroud 220. The present
5 invention includes other embodiments for sealing the region
6 between the motor terminals 212 and the shroud 220 such as,
7 but not limited to, the following. A seal may be formed in
8 this interface region by utilizing a liquid material such
9 as a flowable adhesive, a hot melt adhesive, and silicone
10 sealing materials as known in the art which fill the
11 openings before curing to a hardened state. Alternatively,
12 or in addition, a seal may be formed by utilizing a tight
13 interference fit between the motor terminals 212 or their
14 base, and openings within the motor shroud 220 such as the
15 apertures 550. Alternatively, or in addition, a seal may
16 be formed by insert molding terminals or wires into the
17 motor shroud 220 which can then be electrically connected
18 to the motor terminals 212. Furthermore, a seal may be
19 formed by utilizing a tight interference fit between
20 generally round holes in the motor shroud 220 and wires
21 which connect to the motor terminals 212. It is to be
22 understood that any combination of the foregoing sealing
23 techniques may be used.

24 The preferred embodiment vacuum cleaner 10 also
25 comprises a thermal cutoff assembly 221 (FIG. 8) utilizing
26 a temperature sensitive safety switch that terminates
27 operation of the suction motor 210 if an excessively high
28 temperature is sensed. The motor 210 cannot be restarted
29 until the switch and sensing unit cool and the electrical
30 circuit is broken and connected again, i.e. the switch is
31 reset. That is, both cooling and reset must occur before
32 the motor 210 can be restarted. The thermal cutoff
33 assembly 221 comprises a switching element having a
34 positive temperature coefficient characteristic. The
35 switching element is preferably mounted on the shroud 220
36 of the suction motor 210 and is wired in series therewith
37 to automatically shut off the motor 210 if excessively high

1 temperatures are sensed or an overheat condition occurs.
2 Overheating may occur if one or more of the filters 270,
3 260 or 60 become blocked or excessively plugged, thereby
4 hindering or precluding airflow past the suction motor 210.
5 The motor 210 cannot be restarted until the switching
6 element cools and the electrical circuit is re-established.
7 The electrical circuit is re-established in one of several
8 ways such as by unplugging the vacuum cleaner or turning
9 the power switch off, and then either plugging in the
10 vacuum cleaner or turning the power switch on. The
11 positive temperature coefficient characteristic of the
12 switching element provides an advantage over conventional
13 manual reset thermal cutoff assemblies in that it
14 simplifies the design and eliminates parts otherwise
15 required such as a restart button and related wiring.

16 Most preferably, the thermal cutoff assembly comprises
17 a positive temperature coefficient resistor and a reset
18 component. The positive temperature coefficient resistor
19 is adapted to switch, at a predetermined temperature such
20 as indicative of overheating or a clogged filter, from a
21 low resistance to a very high resistance. When the
22 positive temperature coefficient resistor switches to a
23 high resistance, the cutoff assembly cuts off electric
24 power to the motor assembly. The reset component prevents
25 the restoration of power to the motor assembly until
26 electric power is disconnected from the cutoff assembly,
27 such as by unplugging the unit or turning the power switch
28 off, and the positive temperature coefficient resistor
29 changes back to a low resistance while the unit is
30 disconnected. The change to a low resistance occurs as a
31 result of sufficient cooling of the positive temperature
32 coefficient resistor. Only then may electric power be
33 directed to the motor.

34 The preferred embodiment vacuum cleaner 10 utilizes a
35 reliable mounting configuration and technique for attaching
36 the handle 90 to the upper portion of the vacuum cleaner
37 10. Referring to FIG. 1A, the handle 90 is mounted between

1 the upper portion of the rear housing 20 and the front
2 cover 30. Specifically, the lower region of the handle
3 proximate to a lower distal end 95 is placed within a
4 handle cradle 24 provided on the upper interior surface of
5 the rear housing 20. One or more outwardly extending
6 mounting posts 26 are provided, preferably along the length
7 of the mounting cradle 24. It is also preferred to provide
8 a mounting post 26 at the uppermost region of the rear
9 housing 20 to further secure the handle 90. One or more
10 mounting apertures 96 are defined along the lower portion
11 of the handle 90 such that when the handle 90 is placed
12 within the cradle 24, the mounting posts 26 are aligned
13 with the apertures 96 and extend therein. The handle 90 is
14 secured to the rear housing 20 by attaching the rear cover
15 30 over the handle 90 disposed and aligned within the
16 cradle 24. It is also contemplated that a similar cradle
17 may be provided on the interior surface of the front cover
18 30, preferably with mounting posts that would engage
19 additional mounting apertures defined in the handle 90.

20 The preferred embodiment vacuum cleaner 10 utilizes a
21 transmission control cable configuration substantially as
22 shown in U.S. Patent no. 4,249,281. Referring to FIGS. 1A,
23 2B, and 13, it will be noted that the transmission neutral
24 lock mechanism 130 is disposed on the handle 90 and the
25 transmission 240 is disposed within the upper and lower
26 bases 40 and 180, respectively. The handle assembly
27 comprising the cover 102 and the grip 100 is preferably of
28 a plastic material and is clamped together by means of
29 screws 950 and 952. For this purpose suitable slots 954
30 may be provided on opposite sides of the upper end 91 of
31 the handle 90 through which losses 956 and 958 extend to
32 engage one another. This mounting thereby covers the upper
33 end of the handle 90 and inhibits removal of the handle
34 assembly therefrom and yet permits the handle assembly to
35 move slidably axially at the end of the handle 90. This
36 mounting of course also inhibits relative rotation between
37 the handle assembly and the handle 90.

1 A further slot 960 is provided extending axially and
2 adjacent the end 91 of the handle 90 and a boss 962 extends
3 centrally into this slot from the handle cover 102.
4 Helical springs 132 are affixed to opposite sides of the
5 boss 962 and extend in opposite directions for connection
6 to the insides of the handle 90 at opposite ends of the
7 slot 960. The springs 132 serve to hold the handle
8 assembly at a central position with respect to the slot
9 960, while permitting resilient movement back and forth
10 therefrom, depending upon the forces applied to the handle
11 assembly.

12 In addition, an axially extending slot 964 may be
13 provided at one end of the handle assembly, with a groove
14 966 underlying the slot 964 and having somewhat greater
15 dimensions. The mechanism 130 is slidably mounted with an
16 enlarged base in the groove 966 and a push-button end
17 extending through the slot 964. A leaf spring 968 extends
18 in the groove 966 between the handle 90 and the mechanism
19 130, and has one end thereof fixed with respect to the
20 cover 102, for example by extending into a radially
21 outwardly extending aperture 970 at the end of the groove
22 966. The other end of the leaf spring 968 is formed with a
23 projection 972 toward the handle 90, the projection 972
24 being aligned with a hole 974 in the wall of the handle 90
25 in the central or neutral position of the handle assembly.
26 The spring 978 is normally biased away from the hole 974,
27 with the button in pocket of the slot, but when the button
28 is depressed and urged to a forward position it depresses
29 the spring 978 so that the projection 972 enters the hole
30 974, to inhibit relative sliding movement of the handle
31 assembly with respect to the handle 90 from the neutral
32 position.

33 Still referring to FIG. 13, the Bowden wire 131
34 extends to a suitable clamp 980 adjacent the upper end of
35 the handle assembly. A central wire 982 of the cable has
36 an enlarged upper end 984 which is restrained at the end of
37 the handle assembly. As a consequence, forward or rearward

20

1 movement of the handle assembly will cause the central wire
2 982 to slip forwardly and rearwardly within the outer
3 sheath.

4 The sheathed cable extends from the selector 130
5 downward through the handle 90 and into the upper portion
6 of the vacuum cleaner 10, i.e. between the rear housing 20
7 and the front cover 30. The sheathed cable extends further
8 toward the bottom portion of the rear housing 20, and
9 particularly proximate to the pivot hub 350 provided on the
10 first side wall 310 of the rear housing 20. The sheathed
11 cable extends through its pivot hub 350 and into the base
12 of the vacuum cleaner 10. The cable is connected to a
13 transmission shifting yoke that utilizes a linearly
14 displaceable shifting member which effects shifting to the
15 transmission 240. The active or movable end of the cable
16 is attached to the shifting member and the end of the
17 sheath is attached to a stationary support post provided in
18 the vicinity of the shifting member. In the assembled
19 vacuum cleaner 10, movement of the selector 130 is
20 transmitted to the displaceable shifting member by the
21 control cable.

22 The present invention vacuum cleaner 10 utilizes an
23 elegant locking and affixment configuration between the
24 upper hose 70 and the upper portion of the vacuum cleaner
25 10. FIG. 11 is a detail of the hose adapter 71 and its
26 engagement with the upper portion of the rear housing 20.
27 As shown in FIG. 1A, the hose adapter 71 is disposed
28 between the upper hose 70 and the rear housing 20.
29 Referring to FIGS. 11 and 11A, the hose adapter 71
30 preferably comprises an inclined lip or flange 600
31 extending around at least a portion of the outer periphery
32 of the adapter 71. The lip 600 has an inclined or ramped
33 region designated herein as a cam region 610. The distal
34 end 630 of the hose adapter 71 is inserted within an
35 opening 660 defined in a support ledge 620, generally
36 provided along the interior facing side of the rear housing
37 20. The bag filter 270 is attached to the end 630 by

1 fitting the end 630 into an aperture 270A in a mounting
2 plate 270B provided at the top of the filter 270. The
3 mounting plate is retained between the support ledge 620
4 and a parallel ledge 620A. The opening 660 may be an
5 aperture of circular shape, or may be in the form of a
6 notched passageway defined in the support of ledge 620.
7 One or more support ribs 650 may be provided to strengthen
8 the attachment between the lip 600 and the hose adapter 71.
9 The hose adapter 71 is releasably engaged with the rear
10 housing 20 by positioning it over the opening 660 such that
11 the lip 600 is disposed underneath a locking ledge 640.
12 That is, a portion of the lip 600 is disposed between the
13 locking ledge 640 and the support ledge 620. The hose
14 adapter 71 is then rotated, which due to the action of the
15 inclined cam region 610, induces downward displacement of
16 the hose adapter 71, and specifically the distal end 630,
17 into the opening 660. The lip 600 defines an arcuate edge
18 604 extending around at least a portion of the hose adapter
19 71. It is preferred to provide a flat region 602 such that
20 when the hose adapter 71 is locked into place upon the
21 support ledge 620, the flat edge 602 is flush, or at least
22 not extending beyond, an outer edge 622 of the support
23 ledge 620. The arcuate edge 604 of the lip 600 preferably
24 extends radially outward from the hose adapter 71 a
25 distance such that when the adapted 71 is not locked into
26 place, i.e. and so that the flat edge 602 is not flush with
27 the outer edge 622 of the support ledge 620, the arcuate
28 edge 604 extends outward beyond the edge 622. This
29 prevents the bag cover 80, or other housing component, from
30 being fully engaged with the rear housing 20. This unique
31 interlock configuration requires that the upper hose 70 be
32 properly coupled to the housing of the vacuum cleaner 10.
33 The preferred embodiment vacuum cleaner 10 also
34 utilizes a single wheel drive mechanism. The use of a
35 single wheel drive mechanism offers improved
36 maneuverability, a more economical and less expensive drive
37 assembly, simplicity of engaging the transmission to the

1 chassis, versatility of location relative to the cleaning
2 head or base, and improved serviceability for the vacuum
3 cleaner.

4 The drive assembly and related gear cluster is
5 preferably of the type disclosed in U.S. Patent 4,249,281
6 to Meyer et al., which is herein incorporated by reference.
7 Furthermore, it is contemplated that the drive motor used
8 in the preferred embodiment vacuum cleaner 10 could be of
9 the variable speed type, controlled by an electronic
10 module, which may be in the form of a diode in series or a
11 potentiometer. This would enable the drive speed to be
12 operator adjustable for the pace desired by each individual
13 user of the vacuum cleaner 10.

14 As may be seen most clearly in FIG. 12, the single
15 wheel drive mechanism comprising the drive motor 230, the
16 transmission 240, and associated gear cluster and single
17 drive wheel preferably disposed and mounted within the
18 lower base 180. Mounting provisions may be provided on a
19 side region of the lower base 180, such as the left hand
20 side of the lower base 180 illustrated in FIGS. 1A and 12.
21 A drive shaft is used to couple the single drive wheel 241
22 to the other components of the drive mechanism. Various
23 supporting and mounting provisions can be provided in the
24 lower base 180 for rotatably securing the drive shaft and
25 single drive wheel to the lower base 180. Preferably in
26 this regard, an "eyebrow" notch is formed in a vertical
27 wall or rib in the lower base 180, through which the drive
28 shaft passes. The shaft may be further supported by a
29 bearing disposed within the notch.

30 It is also contemplated to utilize a clutch in the
31 drive mechanism. A problem encountered in self-propelled
32 vacuum cleaners is fracturing or breaking or other failures
33 in the weakest component in the gear chain. This often
34 results during unpowered, rolling transport of the vacuum
35 cleaner, when the user has failed to place the drive
36 mechanism in neutral. Under these conditions, torque
37 generated by the drivewheel rolling across the floor is

1 transmitted through the drive axle to the transmission and
2 eventually to the drive motor. In the event the total gear
3 reduction is relatively high, so that the drive motor will
4 tend to not turn, the weakest component in the gear chain
5 will fail. In order to remedy this problem, a one-way
6 clutch is added to the drive train to disconnect the torque
7 between the transmission and the drive module gear
8 reduction assembly or drive motor.

9 The drive mechanism utilized in the preferred
10 embodiment vacuum cleaner 10 is assembled by utilizing a
11 unique technique for achieving proper spacing between the
12 legs of a yoke and the drive gear cluster. Referring to
13 the noted U.S. Patent 4,249,281, and particularly to FIGS.
14 5 and 6 of that patent, a yoke 120 generally encloses the
15 gear cluster. As described in that patent, a plurality of
16 bearing rivets 130 are provided on downwardly extending
17 arms 124 of the yoke 120. These rivets 130 are utilized to
18 effect proper spacing between the yoke arms 124 and the
19 gear cluster. Although the assembly described in the '281
20 patent is satisfactory in many respects, the present
21 invention provides an improved assembly that is
22 significantly easier to assemble and eliminates the
23 necessity for the bearing rivets 130.

24 As noted, it is important to achieve proper spacing
25 between the ends of the gear cluster and arms of the yoke.
26 In accordance with the present invention, one or more
27 spacing washers are incorporated in the assembly. The
28 width and placement of the washers are such that the gear
29 cluster is placed into proper position with respect to the
30 yoke arms. During assembly, the yoke and the gear cluster
31 are introduced into a machine that automatically measures
32 the total axial thickness of the gear cluster, and also
33 measures the interior clearance or distance between the
34 yoke arms. Using these two measured distances, one or more
35 spacing washers are then dispensed and preferably
36 appropriately incorporated into the gear cluster to arrive
37 at a proper spacing between the gear cluster and yoke arms.

Proper neutral adjustment is preferably accomplished by utilizing one or more spacers, i.e. spacing shims, that are inserted in or between a centering plate of the gear cluster. A single set screw, preferably extending through the yoke, is then tightened to lock the gear cluster, now in its spaced and neutral position, in place with the yoke. Upon incorporation into the vacuum cleaner, and connection to a Bowden wire or control cable 131, the shims are removed and the set screw loosened or also removed.

As further illustrated in FIG. 12, the drive motor 230 and the transmission 240 are encased in a shroud 700. Carbon (or other) dust particles produced by the motor and transmission are prevented from escaping to the environment by providing a suction in the area of the drive motor to draw particles into the airflow which passes ultimately through the final filter 60. The airflow over the drive motor and the transmission is drawn through openings in the shroud 700. This suction is provided by the vacuum motor 210 that provides suction for cleaning as its primary function. According to a preferred embodiment a slot opening 702 is provided in the shroud 700 which communicates with the main floor nozzle chamber.

While the foregoing details are what is felt to be the preferred embodiments of the present invention, no material limitations to the scope of the claimed invention are intended. Further, features and design alternatives that would be obvious to one of ordinary skill in the art are considered to be incorporated herein. The scope of the invention is set forth and particularly described in the claims herein below.